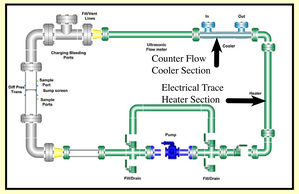
PWR Emergency Core Cooling Systems: research to answer important safety questions

Division of Fuel, Engineering and Radiological Research, Office of Nuclear Regulatory Research

U. S. Nuclear Regulatory Commission, Washington D.C.

Will chemical byproducts cause head loss during post-LOCA recirculation scenarios?



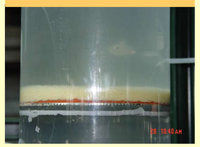
Research conducted at Argonne National Laboratory

Series of bench-top tests to study dissolution of calcium from calcium silicate insulation

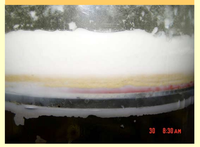
Settling tests to provide insight into whether calcium phosphate flocculent material could transport to the sump screen

Head-loss loop testing to measure effects of chemical byproducts

Initial NUKON/Cal-Sil Debris Bed



Debris Bed after 3 days



Loop Plugged after Test

Key research observations

Testing has shown that chemical products that form in TSP-buffered environments with dissolved calcium can significantly contribute to sump screen head loss.

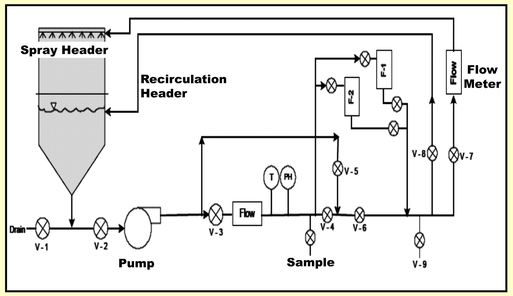
Head loss due to calcium phosphate is greater than for a corresponding amount of cal-sil particulate.

If dissolved phosphate is available, the maximum head loss is governed by the amount of dissolved calcium present. The rate of head loss increases with the rate of calcium phosphate formation.

For more information	Contact information
http://www.nrc.gov/reactors/operating/ops-experience/pwr-sump-performance/tech-references.html	Michele Evans, Deputy Director for Engineering Research Applications Division of Fuel, Engineering and Radiological Research, RES, NRC (301) 415-7210 or mge@nrc.gov

Office of Nuclear Regulatory Research

Will the post-LOCA sump pool environment generate chemical by-products which could contribute to sump clogging?



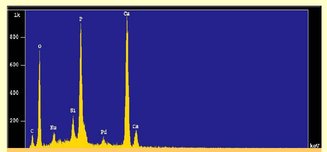
Integrated Chemical Effects Testing (ICET)

Cooperative program with EPRI

Conducted by Los Alamos National Laboratory at the University of New Mexico

Five 30-day tests were conducted under simulated post-LOCA conditions

Test	Buffer	Test Description
1	NaOH	100% fiberglass insulation, high pH, NaOH concentration determined by pH
2	TSP	100% fiberglass insulation, lower pH, TSP concentration determined by pH
3	TSP	80% cal-sil/20% fiberglass insulation, lower pH, TSP concentration determined by pH
4	NaOH	80% cal-sil/20% fiberglass insulation, high pH, NaOH concentration determined by pH
5	Sodium Tetraborate	100% fiberglass insulation, pH determined by achieving target boron concentration.



Test 3 EDS Spectrum of Gel-Like Material

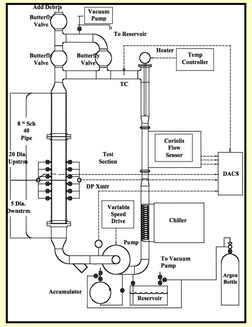
Key research observations

Chemical products and precipitates can form within PWR containment pool environments. Some of these products are amorphous.

Relatively small changes to containment pool variables (e.g., pH, insulation, temperature) can affect the types and amounts of chemical products that form.

Chemical product formation can occur rapidly or evolve over time depending on the environmental conditions.

Can debris head loss data be used to develop analytical models?



Conducted by Pacific Northwest National Laboratory

Characterized head loss across a sump screen and perforated plate for combinations of actual debris bed materials and different debris bed thicknesses

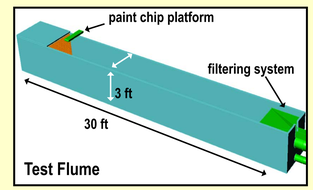
Debris Beds After Retrieval from Test Section

Key research observations

The timing of the arrival of multiple debris bed constituents can cause variations in the concentration of particulate debris, resulting in significant head loss differences.

Measured head loss can also increase due to continued compaction of the debris bed either with time or under varying flow conditions.

Will coatings in containment transport to the sump screen?



Conducted at Naval Surface Weapons Warfare Center – Carderock Division

Investigated the effect of coating density, thickness, size, and shape, and stream flow rate on transportability of paint debris in water

Measured fraction of debris which transports (by floating on the surface, by remaining suspended in the water, or by tumbling or sliding on the bottom of the flume) and fraction which does not transport

Key research observations

The transportability of coating chips is enhanced as the specific gravity (sg) is decreased.

Lower-density chips (sg ~ 1) dropped onto a quiescent water surface remained on the surface indefinitely, tumbled across the floor at lower velocities, and when suspended in a flow stream transported over longer distances.

Higher density chips (sg > 1.7) sank rapidly, were resistant to tumbling at up to 1 ft/s flow velocities, and did not transport readily when suspended.